

Isotope Fractionation Studies in Prestellar Cores: The Case of Nitrogen

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Isotopically fractionated material is found in many solar system objects, including meteorites and comets [1]. It is considered, in some cases, to trace interstellar material that was incorporated into the solar system without undergoing significant processing, thus preserving the fractionation. In interstellar molecular clouds, ion-molecule chemistry continually cycles nitrogen between the two main reservoirs - N and N₂ - leading to only minor ¹⁵N enrichments [2]. Charnley and Rodgers [3,4] showed that depletion of CO removes oxygen from the gas and weakens this cycle such that significant ¹⁵N fractionation can occur for N₂ and other N-bearing species in such cores. Observations are being conducted at millimeter and submillimeter wavelengths employing various facilities in order to both spatially and spectrally, resolve emission from these cores. A preliminary study to obtain the ¹⁴N/¹⁵N ratio in nitriles (HCN and HNC) was conducted at the Arizona Radio Observatory's 12m telescope on Kitt Peak, AZ. Spectra were obtained at high resolution (0.08 km/s) in order to resolve dynamic properties of each source as well as to resolve hyperfine structure present in certain isotopologues. This study included four dark cloud cores, observed to have varying levels of molecular depletion: L1521E, L1498, L1544, and L1521F. Previous studies of the ¹⁴N/¹⁵N ratio towards L1544 were obtained with N₂H⁺ and NH₃, yielding ratios of 446 and >700, respectively [5,6]. The discrepancy observed in these two measurements suggests a strong chemical dependence on the fractionation of nitrogen. Ratios (C,N, and D) obtained from isotopologues for a particular molecule are likely tracing the same chemical heritage and are directly comparable within a given source. Results and comparisons between the protostellar evolutionary state and isomer isotope fractionation as well as between other N-bearing species will be presented.

- [1] Lauretta, D.S. and McSween (2006), H. Y. Jr. (eds.), *Meteorites and the Early Solar System II*, University of Arizona Press, Tucson. [2] Terzieva R., Herbst E. (2000), *MNRAS*, 317, 563. [3] Charnley S.B., Rodgers S.D. (2002), *ApJ*, 569, L133. [4] Rodgers S.D., Charnley S.B., (2008), *ApJ*, 689, 1448. [5] Bizzocchi L, et al. (2010). *A&A*, 510, L5. [6] Gerin M, et al. (2009). *A&A*, 498, L9.